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Vol. III, No. 1 October, 1907

PROCEEDINGS

OF THE

DELAWARE COUNTY INSTITUTE OF SCIENCE

PUBLICATION COMMITTEE:
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MEDIA, PA.

Issued Quarterly. Subscription, One Dollar per annum in advance.
Address all correspondence to the Editor.

Issued November 23rd, 1907

Illinois State Natural History Survey
Library

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PROCEEDINGS

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Delaware County Institute of Science

VOL. III, NO. 1 OCTOBER, 1907

THE STAR VAULT AND THE MOVING OBSERVER.

BY JACOB B. BROWN.*

I have in mind to describe in this paper certain appearances on the star vault which ensue upon certain changes in the position of the observer; and, as many of the circumstances conceived to exist are wholly imaginary, and as some of the positions supposed to be assumed are entirely beyond the limit which it is at present possible to attain, I shall have nothing but the just inferences of science to bear me out in my various statements.

In order, therefore, to insure greater accuracy of conception I may, perhaps, be allowed to remind you that astronomers have the *visible horizon*, whose plane passes perpendicular to the earth's radius through the eye of the observer, and the *rational horizon*, whose plane passes parallel to this through the centre of the earth. This latter need not concern us, the distance measured on a perpendicular between the two being a question of high science. When, therefore, the horizon is spoken of it is the visible horizon that is meant, and this is, as far as our intents and purposes extend, identical with the rational horizon; as will, indeed, appear clear when it is remembered that the distance between the two is the length of

*Through the kindness of Miss Anne Knapp Whitney, the Institute is enabled to publish this article from the pen of its deceased member, Jacob B. Brown.

the earth's radius — about four thousand miles, a quantity which wholly vanishes in face of the other distances which are under contemplation.

As already hinted, it has hitherto been found impossible to reach the neighborhood of the terrestrial pole ; and, even had this extreme latitude been attained, it would be very difficult, with the small, portable instruments in use, to locate precisely the point on the surface of the ground about which all others revolve. But there is nothing to prevent our imagining a victory over all these obstacles ; and the idea entertained by some men of science that owing to causes, surmised but not perfectly understood, the pole of the earth undergoes a small displacement so as to affect the records of latitude, is not yet sufficiently rooted and grounded in general faith to detain us at this stage of progress.

The observer, then, at the pole of the earth has the pole of the heavens directly above his head, and his horizon is the equator of the heavens. All the fixed stars of his hemisphere are, theoretically, visible to the polar observer ; not practically ; for there are refraction, twilight and obscured horizon to take into account. These fixed stars constantly move round him in circles parallel to the horizon-equator. He never sees the stars of the other hemisphere.

The pole of the ecliptic is at 23° 30′ from the zenith-pole, and revolves round it as any other point does. The equinoxes are, of course, in the horizon-equator, and can be only vaguely pointed out by reference to stars. The vernal equinox is in the constellation Pisces ; the autumnal in the constellation Virgo. These points revolve around the pole as the others do.

It will be noticed that the equinoxes are spoken of sometimes as points, sometimes as seasons of the year. Perhaps it would not be amiss if the language had means of distinguishing for us, as we go along, between the two ideas ; but, after all, it matters very little. There is no great difficulty in remembering that the seasons called the equinoxes come

round when the sun in his course passes those accurately determined points in the heavens called also equinoxes. It will dwell in your recollection, moreover, no doubt, that one equinox, the vernal, is called the first point of the sign Aries; the other, the autumnal, the first point of the sign Libra.

It follows from all this that the belt of the zodiac, about 18 degrees in width, or nine degrees on each side of the ecliptic, is always half above and half below the equator. Let me say that the visible portion, regarded as a whole, is a semicircle seen in perspective — that is to say, a semiellipse, standing on the platform of the horizon like an arch whose crown is 23° 30′ above the same, and seeming to slide in that position so as constantly to make the circuit of the heavens.

When the sun is coming towards, and reaches, the equator, he will be seen by the observer at the pole in the horizon; and will, to all appearances, make one daily circuit in that position. But he is constantly changing declination on the ecliptic, and will, next day, be clear of the equator; and next day still farther away from it. The result is that he rises in a slow spiral until at the solstice, or sun-halt, he is 23° 30′ above the horizon. He then turns and goes down again, by the same steps but in a reversed spiral, to the equator, where, at the other equinox, he disappears for six months from the view. He then offers, in turn, the same phases to the eye of one at the opposite pole.

And, generally, it will be sufficient to discuss what is to take place at points of the northern hemisphere; the same being true of the southern, with the proper change of data.

The plane of the moon's orbit is inclined to the plane of the ecliptic 5° 9′. This means that the moon moves on the starry vault within a belt or zone 10° 18′ wide, half on one side of the ecliptic, half on the other. The moon covers, at one time or another, every point of this zone. It follows from what has been said that, as the ecliptic is always half above and half below the horizon, its highest point being at an altitude of 23° 30′, the moon will almost imitate the motions

of the sun, though with irregular monthly, instead of yearly, periods. As to her being seen, that is another matter. During the long polar day her light, when she is "up," is wholly lost in the beams of the sun ; and during the polar night she will revolve within view in a path generally horizontal for about half the time of her circuit ; sometimes more than half, sometimes less ; the reason of the difference being that she is not on the ecliptic, but only near it, above or below, as already stated. A little pondering may be necessary in order to see this clearly, since the fact is only darkly set forth by the astronomers' statement that the nodes of the moon's orbit are in a constant state of retreat upon the ecliptic.

The movements of the planets are not so simple. The paths they trace upon the heavens are the combined result of their own motions and those of the earth.

Such planets as need concern us remain much nearer the ecliptic than the moon does. Venus, the most extravagant in the correct sense of the word, moves within a zone 3° $23'$ above, 3° $23'$ below the ecliptic. Mercury pervades a belt in all fourteen degrees and a quarter wide, but he is rarely seen. (I saw him the other evening, February 9th, 1895, by the way, after my attention had been called to him by our lecturer on astronomy.) As for the Asteroids, as they are invisible without the aid of a telescope, and not at all impressive when so seen, it will interest us but little to remember that the most extravagant of them, Pallas, has an orbit whose plane is inclined to that of the ecliptic at an angle of more than $34\frac{1}{2}$ degrees.

Let the time be summer solstice at the North Pole. The sun is $23\frac{1}{2}$ degrees above the horizon. Let the observer now be transported, instantly, down the meridian on which the sun is, and towards the sun. When he has been moved 23° $30'$ it is clear that he will be on the Arctic Circle ; the time of day noon ; and the sun at its greatest possible altitude for that parallel. But if the same movement from the pole had taken place away from the sun the observer would have found him-

self on the Arctic Circle all the same, but at 180 degrees of longitude distant from his previously imagined position. His time would be midnight. The sun would be 23° 30′ lower than before he moved — in the horizon, therefore, and in the northern horizon, for the visual ray from the sun would pass over the pole.

This is another way of arriving at results which have been stated elsewhere — namely, that the sun just touches the northern horizon at midnight of the summer solstice for the observer on the Arctic Circle; and that at this latitude the extreme altitude of the sun is twice 23° 30′, or 47 degrees above the southern horizon.

It follows also that the Arctic Circle is, theoretically, the lowest latitude at which the midnight sun can be seen. Theoretically is the word. The fact is, that as the sun is raised by refraction, one can see, as the poet words it,

"The midnight Norway sun set into sunrise"

at a latitude lower by more than half a degree — at Tornea, for instance, at the head of the Gulf of Bothnia, latitude 65° 50′ 8″ north.

In a paper headed "A Visible Ecliptic" this matter will be discussed somewhat more in detail.

Let us not forget to notice at this point an illustration of the difference between absolute time and recorded time which is given by our last conception. The observer, namely, passes instantly from the pole, where it is all hours of the day at once, to noon or, at our will in the same instant to midnight. Our earth has no influence upon time — none whatever. Its motions may be made to record time with more or less correctness; but the responsibility is ours.

Our observer may cross the Frigid or the Temperate Zone at what season or hour he shall see fit, but he will never find a vertical sun.

At the Tropic of Cancer, which is a boundary, he will, at the June solstice, have the sun directly overhead at noon.

For one on the other Tropic, on the same meridian and at the same hour, the sun is 47 degrees north of the zenith.

The sun is vertical at noon twice a year for all parts of the Torrid Zone, as will be instantly manifest when we remember that precisely one year elapses between the departure of the sun southward from Cancer and his return northward to the same declination.

For an observer on the equator the two poles are in the horizon; and the equator of the heavens divides the visible vault into two equal portions. It follows that at the equinoxes the sun rises at the east point and passes in a circular arch directly overhead to the west point.

The observer at the equator sees theoretically every star in the heavens in the course of the year. To the same observer the sun's daily course is like that of the stars perpendicular to the horizon, whatever be his declination. It follows that he is, on any given day, as long a time below the horizon as he is above it, and that day and night are equal throughout the year. It is for this reason that the equator is called the equinoctial.

It is a necessary consequence of all this and of what has been said concerning the starry sphere as seen at the poles, that at all points between the equator and the poles there are certain stars near the one pole that never rise and others near the other pole that never set. These last are said, somewhat grandiloquently, to be within the circle of perpetual apparition; the others within the circle of perpetual occultation. They are also called, more simply, circumpolar stars. The greatest possible number of circumpolar stars is, of course, one half of the whole.

This word "number" is the most convenient under the circumstances, and, though inexact, is hardly calculated to mislead. What is meant is merely those contained within the confines of one half of the heavens. The number of these may or may not be equal to that of those contained within the other half.

The circumpolar stars at any latitude are readily distin-

guished. Let the observer conceive a line drawn in his horizon towards the visible pole. This line may easily be conceived as reaching the star vault, and, by the rotation of the earth, describing among the stars a circle with radius equal to the elevation of the pole. All stars within this circle will be manifestly circumpolar. But the elevation of the pole is the latitude of the observer. It follows at once that all stars are circumpolar which are at an angular distance from the pole equal to the latitude of the observer.

The extreme cases are: — First, that of the pole, latitude 90°, where one half of the stars are circumpolar; and second, that of the equator, latitude 0°, where none are so.

The amplitude of a heavenly body is the arc intercepted on the horizon between the east or west point and the meridian passing through the body.

The amplitude of the fixed stars at a given latitude, though affected by precession, is, to all ordinary intents and purposes, a constant quantity. I say, to all ordinary intents and purposes, which means that any change supervening is so minute that unless there be special occasion to notice it the change may safely be neglected. There is however, possibility that in the near future we may be addressed by one having authority upon a matter which will include the orientation, as it is called, of Egyptian temples, and alterations in the structure of these from dynasty to dynasty. Both orientation and alteration will be found to have intimate connection with the amplitude of the fixed stars and changes in the same.

The change, on the contrary, from day to day, of the sun's amplitude at rising and setting, is a phenomenon which can hardly fail to impress itself upon any one in the least accustomed to observe the heavens.

We shall endeavor to show that the sun can, when in the horizon, have any amplitude between 0° and 90°, according to day and hour and position of the observer. In plainer words,

the sun can be seen at certain times and from certain positions in any point of the horizon.

At the time of the equinoxes the sun rises in the east point and sets in the west point for all the world except the very pole. At the pole, namely, there is but one way to look, and that is directly towards the equator. On that day, accordingly, the sun moves in the horizon, which is the equator for the polar observer.

Confining ourselves for the sake of simplicity, now as before, to the northern hemisphere, since the same reasoning applies to both, it is clear that the inhabitants of the Torrid Zone will, as the sun moves toward the Tropic, see him rise and set more towards the north. For a line drawn in the horizon through the sun, the observer and the centre of the earth will make an angle towards the north with the plane of the equator, and, consequently, with the observer's parallel.

At the solstice the polar observer can mark no amplitude, as it is defined, when the sun is rising or setting; for the sun is here, for a season, wholly free throughout the twenty-four hours from the circle on which amplitude is reckoned, the horizon namely.

But if it be remembered that at the equator the horizon is perpendicular to the plane of the same, and at the pole parallel to it, and that between these positions its angle with the plane of the equator is constantly changing as the observer moves on a meridian, it will be seen that he at the pole can make the sun touch the northern horizon by moving southward to the polar circle. If the expression may be permitted, he tilts up his horizon to meet the sun. The sun's amplitude at this moment of rising-setting is said, technically, to be east or west 90° north. And, proceeding with the idea, the observer tilts up his horizon more and more as he goes farther south. Now sunrise and sunset are points common to ecliptic and horizon. As the southward movement continues the two circles intercept greater arcs each from the other. The extreme

amplitude of east or west 90° north is seen constantly to diminish, until the Tropic is reached.

And thus, as the Torrid Zone has already been discussed, the whole hemisphere is accounted for.

When, now, the same has been said, with the proper change of data, concerning the southern hemisphere, it will appear, as stated, that the sun can be seen in every point of the horizon by proper adjustment of season and latitude.

Our conclusions thus far have been reasonably practical; though fancy has aided us to devise the problem which science was to solve. We may look a little farther in the same direction and, if we gain no other advantage from so doing, we shall, at least, have had a wholesome exercise for the imagination.

If one start from the equator and move constantly northeast, his course will be a curve of double curvature, and he will of necessity strike the north pole. For he moves on the surface of a sphere, at an angle of 45 degrees, with a constant series of meridians which converge to the pole. And when the very pole is reached there is but one way to move or look, and that is southward. This fact has been mentioned before, but not the proof of it. We look, namely, east or west along our parallel; and one must leave the pole some short distance behind in order to have a parallel.

It will be understood, with but little effort of memory or imagination, that if one could be instantly transported, say, 90 degrees eastward on his parallel, he would find the time by the clock six hours later than at his starting point; but if the same movement had been made westward he would have found the time by the clock six hours earlier than at his starting point. This state of things is virtually realized by the telegraph. A message leaves London at noon and arrives at Philadelphia, longitude 75° west of Greenwich, so quickly that the time of transit may be wholly neglected. But when it is noon at London it is seven o'clock in the morning here; so that, although starting and arriving at the same moment of absolute time, the message may be said to reach its destina-

tion five hours before it starts. If the message went the other way, it would, by the same process of reasoning, take five hours for the transit.

Now these considerations are elementary enough; but see what comes of them if we give our imagination the rein for a moment or two. Suppose our friend at the pole, so often mentioned, should start to warm himself by running round the pole. Whichever way he moved, whether to right or left, he would bring the sun again and again to the meridian before he stopped to take breath; and, unless he took heedful note of the turns and carefully ran the same number in the opposite direction, he would completely upset his record of the day of the month. In fact, by diligent running in the proper direction he might make himself any age he chose. In other words, he could place himself as far back in the past or as far forward in the future as his muscles would carry him.

Again, if he advanced from the pole southward, say, twenty-eight hundred and one yards and a fraction, and then moved on his parallel, he would make the circuit of the earth in ten miles of walking, and as long as he could cover one-twenty-fourth part of this, or seven hundred and thirty-three yards and one foot per hour in a westerly direction, he would keep the sun on his meridian and prevent the date from changing. The great globe would be to him neither more nor less than a magnificent treadmill.

We have gone so far in our conceptions and placed our observer in such hitherto impossible places, that we may as well pass over into miracle for a moment, eliminate gravity, station him, without visible means of support, directly above the pole of the earth, and see what comes of it.

The atmosphere, which is virtually part of the earth, and whirls around with it, has no influence whatever upon this suspended man, for he is at the neutral axis. He sees the earth revolve beneath him once in twenty-four hours, and points upon it have but a slow motion; for, as we have seen,

an object 8404 feet from the pole would move but 733 yards in an hour, and a point close to the pole only twice as fast as the hour hand of a watch.

The stars have no courses; they are fixed forever in their places. They are but a permanent background. The sun appears at the equinox, moves in six months through the half of the ecliptic which is above the horizon-equator, then disappears at the other equinox, and is seen no more for half a year.

The moon rises at her appointed time, and not far distant from the point where the sun appears. For about a fortnight she is constantly above the horizon; then goes down, on the side opposite to her rising. Needless, perhaps, to remind you that during the polar day her beams are lost in those of the sun.

The planet Mercury and the planet Venus, being inferior planets, will be seen before the sun's yearly rising in the constellation Pisces, and after his yearly setting in the constellation Virgo. The path they trace upon the heavens will be as it is to the ordinary observer upon the earth's surface, a curve far from simple — the combined result of their own movement and that of the earth.

The superior planets may at the appointed times be seen, all through the long polar night, just as they may all through the short terrestrial night. When, namely, they are on the opposite side of the equator to the sun they will be seen; when they are on the same side they will not be seen.

Now, I wish my observer to move down the meridian toward the equator, still preserving his disconnection with the earth. But if he do so move he will, from causes set forth above, have a wind abeam to contend with, constantly increasing in force until, at our latitude, for instance, it will have a speed of 766 miles per hour, and at the equator a velocity of 1000 miles per hour. He could not endure this. It would tear him into little pieces just as if he had been blown from a gun. So we will suppress the wind as we have suppressed gravity; the one operation being as easy as the other; and we will have him move at will up and down the

meridian, merely taking care not to be in the track of on-coming terrestrial protrubances.

Nor must he in his wholly unaccustomed freedom from the influence of gravity forget, lest his records fall into confusion, that a straight line drawn through him away from the centre of the earth is said to point upwards, and through him towards the centre of the earth, downwards — wherever he may be.

Let his first stop be at the Arctic Circle at the time of the summer solstice. If he have moved down the meridian away from the sun he will, at the halt, find the sun in his northern horizon. But the horizon is here the ecliptic of the heavens, as set forth elsewhere; and it follows that as long as he remains over the polar circle he will see the sun make yearly circuit of the horizon; never rising, never setting. The surface of the earth moves away eastward beneath him at the rate of more than 400 miles per hour, and he does not distinguish objects.

But when he has reached the latitude of the equator, all is flying beneath him at the rate of a thousand miles an hour, and is reduced to one uniform color and surface; though he may, possibly, distinguish land from sea. He looks up and finds that one half the stars he saw when at the pole have disappeared from view and others have moved up from the opposite quarter to fill their places. They are all now moveless, as before.

The moon and the planets order themselves as when he was at the pole, but at different levels.

The sun rises in Pisces and sets in Virgo after six months; but the altitude he reaches is 66° 30′ above the horizon, instead of 23° 30′.

And, now, when our privileged associate has assured himself by the faithful witness of the eye concerning these and many other wondrous things which he knew before by theory, and when he has duly steeped his soul in the tremendous loneliness of his position, he may, if he sees fit, return to his native latitude and drop back among his friends.

FUNGI.*

BY SANFORD OMENSETTER.

In all the fields of botanical research there can be no more interesting subjects than the fungi, which comprise cellular, flowerless plants, nourished through their spawn or mycelium; living generally above ground and propagated by spores of various colors. They are closely related to algæ, but grow in different situations — in green pastures, in meadows and woodlands, on decaying trees; some on cereals, potatoes and other vegetation, which they destroy; others on books in damp situations, and some on man or animals under certain conditions.

The spores correspond to the seeds in other plants, but differ from the latter in being composed simply of cells and not containing an embryo. Under favorable conditions the spores develop into the spawn or mycelium, which is the vegetative part of a fungus and consists of inconspicuous white down and strings, and may be either filamentous or cellular.

Almost every earthly thing is liable to be infected by this ubiquitous race. Some spread themselves over our fruits; others attack our bread, cheese, pickles or other manufactured articles of food. "When our vinegar becomes mothery," writes one observer, "the cause of the mischief is a fungus; if pickles acquire a bad taste, if catsup turns ropy and putrefies, the fungi have a hand in it all. Their reign stops not here — they even prey on each other. The close cavities of nuts occasionally afford concealment to some species; others like leeches stick to the bulbs of plants and suck them dry; some (the architect and ship builder's bane) pick timber to pieces as men pick oakum. One variety has a particular fancy for the hoofs of horses and the horns of cattle, sticking to these alone. The body of the domestic fly is liable in autumn to be attacked by a parasitic fungous growth."

The word fungi has been adopted into the English language directly from the Latin, though originally from the Greek

* Synopsis read before the Institute.

sponggia, a sponge, doubtless in allusion to their texture.

The members of the fungus tribe are similar in structure, and form an important and most remarkable division of the vegetable kingdom. Many of the species are exquisite in shape and coloring, while others are extremely valuable as articles of diet or of medicine.

In the program of the world's development, fungoid growths have been found as early as the carboniferous period, or coal age.

The chemical structure of fungi is said to be the most highly animalized; or, in other words, to partake more of the nature of animal composition, than that of any other vegetable. Besides the intimations of this circumstance that are afforded by the smell of some of the species in decay, which partakes much of the character of that of putrid meat, and the strong, meat-like flavor which some of them possess when cooked, we find the following fact stated — that, "like animals, they absorb a large quantity of oxygen and disengage from their surfaces a large quantity of carbonic acid; all, however, do not exhale carbonic acid, but in lieu of it some give out hydrogen and others azotic gas (now known as nitrogen). They yield, moreover, to chemical analysis the several components of which animal structures are made up; many of them, in addition to sugar, gum, resin, a peculiar acid called fungic acid,* and furnish considerable quantities of albumin, adiposine and osmazome, which last is that principle which gives its peculiar flavor to meat gravy."

Crystals of calcium oxalate are to be met with on the surfaces and in the intercellular spaces of many of the larger fungi.

Chemical analysis of the cell membrane shows that it possesses the elementary constituents of cellulose; but since the uncolored and unthickened membrance does not commonly exhibit the characteristic reaction of cellulose towards

*An acid contained in the juice of most fungi. It is said to be a mixture of citric, malic and phosphoric acids.

iodine* nor towards many of the reagents commonly used in testing typical cellulose, it is necessary to apply to it the special term fungal cellulose.

A great distinction between the fungal cell and other vegetable cells is that the former is wholly destitute of chlorophyl. Chlorophyl is the essential constituent that imparts the green coloration to the leaves and stalks of plants. Its nature is still doubtful, never having been obtained in a perfectly pure condition.

George Murray states that "in their mode of life fungi are controlled by this absence of chlorophyl. Without it they cannot assimilate, and are therefore driven to obtain their nourishment by taking up the carbon compounds assimilated by other organisms. Their mode of life is either parasitic or saprophytic. As parasites they inhabit the bodies of living plants and animals, and even of other fungi. In some cases they kill their hosts, and in others encourage growth, as in the case of the lichens,† and between those two extremes various degrees of parasitism occur. As saprophytes they promote the decomposition of dead organic bodies, and thus aid in the production of carbonic acid, water and ammonia, the elements of which return to the course of organic life."

Jodin relates that "some fungi absorb as much as six per cent. of their nitrogenous content in the form of nitrogen gas from the atmosphere. In the decomposition of fungi, ammonia is formed from the nitrogenous compounds. As parasites and saprophytes their influence as regulators in the economy of nature may be compared with that of the lower animals living the same mode of life."

*Cellulose moistened with iodine tincture and then treated with strong sulphuric acid assumes a blue color.

†According to Schwendener, "a lichen is not an individual plant, but rather a community made up of two different kinds of individuals belonging to two distinct classes of cryptogams, viz.: — A master fungus and colonies of algal slaves, which it has sought out, caught hold of, and retains in perpetual captivity in order to provide it with nourishment."

Of more immediate interest are the esculent fungi. Of these by far the greater number are comprised in the family of Agarics, a division which takes its name from Agaria, a region of Sarmatia. Our English word mushroom, by which all kinds of edible fungi are commonly designated, has a French origin and comes from the word *mousseron*.

Among one thousand American fungi described by Charles McIlvaine, some seven hundred are catalogued as fit to be eaten, having more or less commendatory flavors, while less than a dozen are fatally poisonous. With most persons, but one species, the well-known meadow mushroom, is worthy of confidence. Their creed is expressed in the quaint words of the old herbalist, Gerard, who said,

> "The meadowe mushroom is in kinde the best;
> It is ill trusting any of the rest."

And yet, by those living in the country, what teeming wealth of nutriment is allowed to go to waste because of lack of knowledge.

It is a pleasant thing to sally forth early in the day, under the first burst of sunshine which breaks out on a soft, clear morning in September, and to see how the night dews have been at work hastening the growth of fungi.

We need hardly say that mushrooms are excellent pickled. The way to preserve them is to select all the buttons; place them, skins and all, in a stewpan with allspice, salt and pepper; stew them until they have given out every drop of their juice and have re-absorbed all those juices, charged with the flavor of the spices among which they had been stewing. When this process is completed, add as much hot vinegar as will cover your mushrooms, boil them just for a minute, and they are finished. The large, broad specimens are delicious broiled with salt and pepper, and the middle sized kinds stewed in their own juice, with a little pepper, salt and butter.

Throughout the continent of Europe, plants of the fungus

tribe are eagerly sought by all classes of men, and form the chief, if not the sole diet of thousands, who would otherwise be scantily provided with aliment. But fungi are not only the tolerated food of the poorer classes; they are also highly prized by the rich man and the epicure.

In Italy and Germany immense numbers of the various species of this tribe are sold in the markets, and produce an almost incredible amount of income. It is said that in Rome, so important are the fungi as an article of commerce, there is a public officer appointed to inspect those exposed for sale and superintend this branch of the revenue; for in that mart a tax is laid on quantities exceeding ten pounds weight, which may be offered for sale. All shipments brought to Rome are weighed and sealed up, and those destined for the day's consumption sent to a central depot. If, among the contents of the baskets, any stale, maggot-eaten or dangerous specimens are found, they are sent under escort and thrown into the Tiber. Another remarkable circumstance is the law, that if a specimen of the common mushroom be discovered, it also is to be thrown into the river. Whatever the Romans may say, the latter fungus is a delicious article of food, and very rarely an injurious effect arises from partaking of them.

All those more or less spherical fungi called puff balls, furnished with a membranous, white covering, and filled, when young, with a white, compact, homogeneous pulp, are fit to eat. Personally, when in good condition, the writer prefers them to mushrooms. Their integument removed, they may be cut in cubes and stewed, or sliced and fried like egg plant. They are of delicate flavor and very nutritious.

Several species abound in the vicinity of Media. The puff balls are frequently pre-empted by a sort of beetle, which burrows therein, spoiling desirable specimens. It is said that cows are partial to this variety of fungus.

For the purpose of benumbing bees, dried puff balls have been burned under hives, while the spoilers rifle them of their hoarded treasure. In former days, as they will, when old,

hold flame for a long time, these fungi were used as tinder, and were often carried in a state of ignition by rustics, for the purpose of lighting their cottage fires.

One more noted species, as yet undiscovered in America, may close our very imperfect account of edible fungi. The truffle is found growing in clusters in clayey or sandy soil some inches under the ground, likewise in chalk, and is common on the Wiltshire downs, as well as in woods both in England and Scotland. The form of truffles is nearly spherical, and their color approaching black. They are studded with pyramidal tubercles, and their spawn is phosphorescent. In England they seldom exceed a few ounces, but on the Continent a weight of several pounds is said to have been attained. As there is above ground no sign by which truffles may be located, discovery is difficult; but so keen have men been in their appetite for this delicacy that they have hit on the plan of having dogs to scent them out. When the animals nose the prize, they stand and whine and scratch on the spot until their masters dig and take possession of the tubers. It is reported that there was known a man capable of exercising this extraordinary function, detecting truffles in the earth by sense of smell.

The expansive growth of fungi may next call for a few remarks. An account has been given of a paving stone, twenty-one inches square and weighing eighty-five pounds, which was raised an inch and a half from its station by a cluster of toadstools growing beneath. Many other facts, that attest the rapid growth of fungi, have been related by different authors. One of these peculiar plants was known in three weeks to reach a girth of seven feet, five inches and the weight of thirty-four pounds, and others the weight of twelve pounds in a few days.

But none of these statements, remarkable as they seem, are so wonderful as one made by Sir Joseph Banks, of a circumstance which occurred under his own roof. He avers that a friend having sent him a cask of wine which was too new

and sweet for immediate use, it was locked in a cellar to mature. At the end of three years, Sir Joseph, supposing that time had now done its work, proceeded to open the cellar and inspect its contents. Little did he think how nature had been employed, and of the surprise which lay in wait. The door refused to open. Being invincible by gentle means, it was fairly cut away, but entrance was no nearer than before. The cellar was found literally full of fungous growth, which had borne the cask to the ceiling, where it stuck, upheld by fungi, the produce of the wine, which had leaked and formed this monstrous growth.

Another English writer, Dr. Withering, says: — "Mr. Stackhouse had repeatedly mentioned to me a large, esculent fungus found on the sea coast in Cornwall, which is, I believe, a monstrous variety of this species. Its whole habit is very large, the button as big as a potato, the expanded pileus (or cap) eighteen inches over, the stem as big as a man's wrist, etc." He also tells of a specimen which weighed fourteen pounds, and was found in an old hotbed.

But huge as this fungus must have been, it by no means equals one grown in Pannonia, and noted by Clusius in his "History of Plants." Of this immense specimen (supposed to have been *Polyporus frondosus*) "after satisfying the cravings of a large, mycophilous household, enough remained to fill a chariot!"

The phosphorescence or luminosity observed in several fungi has given rise to many absurd conjectures. Such a phenomenon depends on the respiration of oxygen, luminosity ceasing when oxygen is unavailable.

The coal mines of Dresden exhibit the interesting circumstance of fungi which emit light like pale moonbeams. A Mr. Gardner states that while passing along the streets of a Brazilian town he "observed some boys amusing themselves with what appeared to be large fireflies, but which proved on inspection to be a fungus belonging to the genus *Agaricus*, which gave out a brilliant, phosphorescent light of a pale

green." He next day obtained considerable quantities, and found that a few of them in a dark room gave sufficient light to read.

Concerning a native luminous species, *Clitocybe illudens*, observed by the writer in Lower Providence, but not tested, Charles McIlvaine has this to say : —

"Grows in clumps or large masses about stumps or decaying trees, from August to October. Its bright, deep yellow is attractive from a distance. As many as fifty plants may form a cluster.

"The mysterious property of phosphorescence is possessed by this fungus. As heat is known to develop in masses of the fungus, it is of interest to know whether it is from the phosphoresence or a ferment. Its radiance by night surpasses its splendor by day. Mr. H. I. Miller, of Terre Haute, Indiana, first drew the writer's attention to this quality. A large box of specimens sent by him retained their luminous quality after three days of travel to such an extent that the print of a newspaper could be read when held close to the mass.

"Mr. Miller writes : 'There is something about this fungus which generates heat. When I bring in a basketful of it, for the pleasure its phosphorescence affords my friends, I find that after having been in the basket for two or three hours, and while piled one bunch on top of another, that to insert one's hand among the different clusters is like putting it close to a red hot stove.'

"This fungus is so inviting in quantity and beauty that one turns from it with a regret that lingers."

The species in question contains a minor, irritant poison, acting locally on the gastro-intestinal tract, and should not be eaten.

Where in woodland borders there stands a stately toadstool, siren-like, immaculate — beware the tempter, for within that queenly beauty lies the draught of death.

Perhaps if all cases of fatal poisoning by supposed mushrooms were traced to their source, the *Amanita phalloides*

would be found to blame. Not less relentless than the Socratean hemlock, its insidious alkaloid stealthily clasps its victim in a grip that scarce knows mercy. The poison of *Amanita* has in some cases been counteracted, in early stages of an attack, by minute hypodermic injections of atropine sulphate.*

"*Amanitæ*," relates Charles McIlvaine, "are the most beautiful and conspicuous of fungi. While there are comparatively few species of them, the individual members are plentiful in appearing from spring until the coming of frost. They are solitary or gregarious in growth. Occasionally two or three are found together. They frequent woods, groves, copse, margins of woods and land recently cleared of trees. They are seldom found in open fields. A careful study of all their botanic points should be the first duty of the student of fungi. Familiarity with every characteristic of the *Amanitæ* will insure against fatal toadstool poisoning, for it is the well-grounded belief of those who have made thorough investigation that, with the exception of *Helvella esculenta*, now *Gyromitra esculenta*, the *Amanitæ*, alone, contain deadly poison.

"They are the aristocrats of fungi. Their noble bearing, their beauty, their power for good or evil, and above all their perfect structure, have placed them first in their realm; and they proudly bear the three badges of their clan and rank — the volva or sheath from which they spring, the kid-like apron encircling their waists, and patch marks of their high birth upon their caps.

"The *Amanitæ* are of all colors, from the brilliant orange of the *Amanita Cæsarea*, the rich scarlet or crimson of *A. muscaria*, to the pure white of the *A. phalloides* in its white form." †

A prominent writer has fittingly observed: "It is exceed-

* Reported by Dr. J. E. Schadle, Shenandoah, Pa., August, 1885.

† The color of the pileus of A. phalloides is quite variable, white and brown being the prevailing effects. A familiar case of color phasing in birds occurs in the screech owl, whose plumage may be red or gray.

ingly unfortunate that these deadly poisonous toadstools do not give some warning either in an unpleasant taste or contain an irritant which would act locally to cause emesis and purgation, for in that case the patient would get rid of the poison before such large quantities were absorbed and fatal poisoning would be less frequent. They are not at all unpalatable, and sometimes large quantities are eaten by mistake."

Professor Charles H. Peck, New York State Botanist, in his Forty-eighth Report gives the following very explicit directions for distinguishing between the poisonous *Amanita* and the common mushroom : —

" Poison Amanita—Gills persistently white. Stem equal to or longer than the diameter of the cap, with a broad, distinct bulb at the base.

" Common Mushroom — Gills pink, becoming blackish-brown. Stem shorter than the diameter of the cap, with no bulb at the base. The mushroom does not grow in the woods."

An extremely poisonous species found in this locality, the fly agaric (*Amanita muscaria*), formerly grew in great luxuriance beneath coniferous trees in Media cemetery. It attains a larger size than *A. phalloides*, and the top of the cap is at first red, turning to orange and becoming paler with age. Warty excrescences, the remnants of the universal veil originally enclosing the young fungus, are also plentiful.

The particular toxic principle of these plants is known as muscarine, a well-known alkaloid isolated by Schmideberg and Koppe in 1869. Its chemical formula has been represented as follows : —

$$C_2H_3\begin{cases} N(CH_3)_3.OH \text{*} \\ (OH)_2 \end{cases}$$

An enthusiastic mycophagist has described his experience in testing the fly agaric : "A raw piece of the cap, the size of

* Known technically as oxy-choline. It may be prepared synthetically through the oxidation of choline by nitric acid. Small wonder that such a compound plays havoc with the interior.

a hazel nut, affects me sensibly if taken on an empty stomach. Dizziness, nausea, exaggeration of vision and pallor result from it. The pulse quickens and is full, and a dreaded pressure affects the breathing. I have not noticed change in the pupil of the eye. Nicotine from smoking a pipe with me abates the symptoms, which entirely disappear in two hours, leaving as a reminiscence a torturing, dull, skull pervading headache."

Small amounts of the dried *Amanita muscaria* are said to be used by inhabitants of northern Asia for the stimulating effect upon the nervous system, producing, like other narcotic poisons, a dreamy state of intoxication, deepening into sleep.*

Dr. W. S. Carter, of Galveston, Texas, who has made a careful study of fungal poisoning and its treatment, groups the toxic species in two classes: —

First — Those containing minor or irritant poisons, which act locally on the gastro-intestinal tract, such as *Clitocybe illudens* and others. From the prompt way in which vomiting and purging begin there seems to be no doubt of their local irritant action on the alimentary canal. Such symptoms may not be regarded as dangerous unless the poison be taken in enormous quantities or by one in poor health.

Second — Those containing major poisons which act on the nerve centres after absorption, causing symptoms to appear a long time after the poison has been taken and very often terminating fatally. This group includes the various species of *Amanita*. From eating them, vomiting and purging may also happen as prominent symptoms, but generally only occur late — ten to fifteen hours after partaking — and are due to the action of the poison on the nerve centres. This is clear from the fact that these symptoms appear when the poison is given either hypodermically or intravenously to animals.

By means of over one hundred experiments upon lower animals, Dr. Carter has arrived at the following conclusions: —

* Von Boeck, Ziemssen's Cyclopedia of Medicine, Vol. VII, p. 927.

The deleterious principle common to toxic fungi of the second group is muscarine, above named.

Acting upon the nerve ganglia of the heart, a frequent result of its absorption is cardiac inhibition, which may be controlled by atropine.

Owing to the presence of other toxins, life generally ceases in two or three days after poisoning begins.

Toward counteracting late effects, physiological salt solution (.6 per cent. table salt), in conjunction with other remedies, has been recommended.*

The experiments would seem to show that *Amanita phalloides* is much more fatal than *A. muscaria*.

Toadstool poisoning differs from most poisonings in the long time elapsing before death in fatal cases.

No statement can be made as to the cause of this late death, but it would appear to be due to some disturbance of nutrition.

Late death occurs not only in animals, but in most of the cases of poisoning in man recorded in medical literature.

In the case of *Amanita phalloides*, the serious symptoms appear early and continue till the end.

With *Amanita muscaria*, the early effect of the muscarine soon passes off or can be removed by atropine, but the late symptoms still prevail and remain until death.

*Delobel, in "Presse medicale," September 30th, 1899, reports a remarkable case of recovery after the injection of a large amount of normal saline solution. A man, aged fifty-two, ate some A. phalloides. Two full doses of atropine were given hypodermically, as well as 10 cc. of ether, and 200 cc. of strong coffee with 20 cc. of rum were given by the mouth and hot bottles applied externally. The patient becoming worse, one liter (one quart) of normal saline solution was injected hypodermically. Improvement began in fifteen minutes after the injection, and the patient went to work the next day.

FINDING OF THE BACILLARIAN BEDS ON THE OCEAN BOTTOM.

BY ARTHUR M. EDWARDS, M. D.

The finding of Bacillarian beds, in fact the layers of diatoms, on the ocean bottom, is not new, although the importance of it is just now shown. For as the Bacillaria make up the clayey stones of vast regions in the world, they are also seen in the rock that is forming now, called "recent" by geologists, in the bottom of the sea.

They have been observed since 1818. In fact Bacillaria, or diatoms themselves, were not known much before then. And the discovery that they are synonymous with the great deposits of the world, those namely of Denmark, Spain, Greece, Africa, North America, South America, Japan and New Zealand, is likewise not new. In Denmark they are placed, tentatively, in the Late Tertiary, near the Recent strata containing living forms; in Spain in the Miocene, or still lower in the Oligocene Tertiary; in Greece, by Ehrenberg, who discovered them, below, in the Cretaceous; in Africa, also by Ehrenberg, in the Tertiary; in North America, by Rogers, in the Tertiary; in California, by Blake, who follows Ehrenberg in this, in the Tertiary. But here they are first studied thoroughly, and I put them in the Recent, because holding Recent forms identical with those brought home by the "Challenger" and "Tuscarora." In South America, in the North, in Peru, where geology has not been studied, they have not been placed at all. But from the South, in Patagonia, they were sent by Darwin to Ehrenberg, and placed by doubtful evidence in the Tertiary. Hatcher brought back some rock which he thought was Tertiary. I have examined this and I find Bacillaria in it. From Japan Pompelley brought back some rock which he submitted to me, and placed it doubtfully in the Tertiary. I reported on it at the time in the "Smithsonian Transactions" and found it was the same as the Virginian and Californian rock, in the way of

Bacillaria. In New Zealand, Hector considers the Bacillarian rocks to be Cretaceous — or rather, Upper Cretaceous. Now I have to announce that in my opinion they are Recent. And so they have been thought for some years. These all contain marine forms of Bacillaria, or rather those that live in the ocean water. I do not mean along shore, but in the midst of the ocean. But marine, brackish and fresh water are misleading terms. For we find them in ocean and along shore where they are influenced by fresh water, and even in fresh water away from the influence of the sea.

But let me state exactly what is known of the deposits as revealed in soundings.

The first successful attempt to bring up and examine the soundings was made in 1818 by Sir John Ross, who made a voyage to the Arctic regions in that year. This is detailed in the appendix to the narrative of his soundings in Baffin's Bay in 72° 30′ N. and 77° 15′ W., when he succeeded in bringing up from 1050 fathoms (or 6300 feet) "several pounds" of a "fine, green mud" which formed the bottom of the sea in that region. No microscopical analysis of this mud is recorded. Captain (afterwards Sir Edward) Sabine, who accompanied Sir John Ross at one time on this cruise, says this mud was "soft and greenish and that the lead sank several feet into it." Microscopical science was young then, and in 1818 Foraminifera, Radiolaria and Bacillaria were comparatively unknown. At any rate, the soundings were essentially the same microscopically as those brought home by the U. S. S. "Tuscarora," which I have examined and reported upon. A similar "fine, green mud" was found to compose the sea bottom in David Straits by Goodsir, in 1845. As I have said, nothing was spoken of the microscopic examination of this mud, but it was reported on by Sir J. D. Hooker, who first described it as coming from the Atlantic Ocean region. In this case it was green, but light colored, almost white, and came from near the southern pole. It was almost entirely made up of the loricæ of Bacillaria. As it is described in two scarce books

I will detail it here. First: It is in "The Cryptogamic Botany of the Antarctic Voyage in H. M. Discovery Ships 'Erebus' and 'Terror' in the Years 1839-1843," by Joseph Dalton Hooker, 1845, and in "The Transactions of the British Association for the Advancement of Science, Oxford, 1847." In the latter Dr. Hooker says: —

"The waters and especially the newly formed ice of the whole Antarctic Ocean between the parallels of 60° and 80° south were found by the author to abound in an order of organisms, whose true nature had until very recently been disputed; but which the recent discoveries of Mr. Thwaites in England had proved to belong to the vegetable kingdom. This order occurred in such countless myriads as to stain the sea everywhere of a pale, ochreous brown, in some cases causing the surface of the ocean, from the locality of the ships as far as the eye could reach, to assume a pale brown color. Though particularly abundant in the Icy Sea, these plants are probably uniformly dispersed over the whole ocean; and being invisible from their minuteness, can only be recognized when washed together in masses and contrasted with some opaque substance. They were invariably found in the stomachs of Salpæ and other sea animals, in all latitudes between that of the north tropic and the highest parallel attained by the Antarctic expedition. Many processes were employed for obtaining the species, which on being brought to Europe were placed in the hands of Prof. Ehrenberg, of Berlin, for examination and publication. A consideration of the results of Prof. Ehrenberg's examination, and of his observations on these plants, has led Dr. Hooker to the following results: —

"I. That a vegetation very different from Lichens, Mosses, etc., (orders which had hitherto been supposed to comprise the most Antarctic vegetables), abound in the waters of the Antarctic Circle, the species increasing in numbers with the latitude up to the highest point attained by man.

"II. That on this vegetation the whole of the animal kingdom, which swarms in the waters of the Antarctic Ocean,

perhaps ultimately depends for its existence. It maintains that balance between the animal and vegetable kingdom which prevails through all other latitudes; probably also purifying the vitiated atmosphere as plants of higher orders do in most temperate regions.

"III. The genera and species of Diatomaceæ collected within the Antarctic Circle are not all peculiar to those latitudes; on the contrary, some of the latter occur in every country between Spitzbergen and Victoria Land. Others, or even some of these, have been recognized by Prof. Ehrenberg as occurring fossil in both Americas, the south of Europe and the north of Africa, in tripoli stone and volcanic ashes ejected by living and extinct volcanoes; whilst others again have been found floating in the atmosphere which overhangs the tropical Atlantic; for Mr. Darwin during the voyage of the "Beagle" collected an impalpable dust which fell on Captain Fitzroy's ship when to the west of the Cape de Verde Islands, and which on examination was proved to consist of the remains of Diatomaceæ, including species common to the Antarctic regions.

"IV. The death and decomposition of the Antarctic vegetation are gradually producing a submarine deposit or bank of vast dimensions. This bank consists mainly of the shields (the siliceous coatings of Diatomaceæ) intermixed with Infusoria and inorganic matter. Its position is from the 76th to the 78th degree of south latitude, and between the meridians of 26.5 east and 160th west longitude, thus occupying an area of 400 miles long by 120 wide. All the soundings taken over this deposit were in the finest green mud, occasionally mixed with sand, and a depth of between 200 and 400 fathoms. The lead sometimes sunk two feet into this peaty deposit, and on examination of what it brought up, showed the bottom to consist in a great measure of the remains of the species living on the surface.

"V. This deposit may be regarded as resting on the shores of Victoria Land and Barrier, and hence on the submarine flanks of Mount Erebus, an active volcano upwards of

12,000 feet high. Knowing as we do that Infusoria, Diatomaceæ, and other organic constituents, enter into the formation of the pumice and ashes of other volcanoes, and are still recognizable in these minerals, it is perhaps not unreasonable to conjecture, that the subterraneous and subaqueous forces which keep Mount Erebus in activity, may open a direct communication between the diatomaceous deposit and its volcanic fires.

"VI. The diatomaceous deposit flanks the whole length of Victoria Barrier, a glacier of ice 400 miles long, whose seaboard edge floats in the ocean, whilst its landward is extended in one continuous sweep from the crater of Mount Erebus, and other mountains of Victoria Land, to the sea. The progressive motion of such a glacier, and accumulations of snow on its surface, must result in its interference with the deposit in question, which, if ever raised above the surface of the ocean, would present a striped bed of rock which had been subjected to the most violent disturbances."

In 1850 Captain Penny collected in Assistance Bay, in Kinstone Bay, and in Melville Bay (which lies between 73° 45′ and 76° 40′ N.), specimens of the residuum left by melted ice and the sea bottom in these localities. These were sent by Dr. Dickie, of Aberdeen, to Ehrenberg, who examined them and reported upon them in the Berlin *Akadamie Monatsberichte* for 1853. There were figured in it siliceous loricæ of Bacillaria and also spiculæ of sponges. And also some of what he called Polycistinæ, or Radiolaria, as we should call them now, but no Foramenifera apparently occur only in certain strata or regions of the sea bottom.

In the March, 1854, number of the *American Journal of Science*, page 176, Prof. Bailey gave "The Examination of Some Deep Sea Soundings from the Atlantic Ocean," in which he detected this microscopic feature of the soundings and says they were in continuation of some detailed in the *Smithsonian Contributions to Knowledge, Vol. II, Art. 3*, Therein he made known the soundings along the coast from the depth of 51 fathoms southeast of Montauk Point in 90

fathoms southeast of Cape Henlopen, Fire Island Inlet and Little Egg Harbor were chiefly made up of vast amounts of foramenifcrous shells, rivalling in abundance the deposits of analogous species which he had found to compose the immense beds under the city of Charleston, South Carolina. He examined the soundings brought home by Lieut. Berryman, of the U. S. S. "Dolphin," made by using Lieut. Brooke's lead. There were five soundings made in 1080, 1360, 1580, 1800 and 2000 fathoms. None contained gravel or sand. All contained microscopic foramenifcrous shells. They all contained Bacillaria, which Bailey referred to *Coscinodiscus lineatus*, *C. excavatus* and *C. radiatus*. They all contained what he called Polycistiniæ, that is to say, Radiolaria, and also *Dictyocha jübulæ* (G. E.), which is now relegated by Haeckel to the Radiolaria also.

He also says that "the Cretaceous deposit of New Jersey presents no resemblance to soundings, and are doubtless littoral, as stated by Prof. H. D. Rogers."* Thus showing how they were produced before the era of "species generation" made certain by the researches of Darwin, who followed Carpenter.

In the year 1856 Prof. Bailey published his remarkable researches on soundings, in which he found Bacillaria, that is to say, Diatoms, and as he gave me the publication I wish to be explicit. It was a remarkable addition to our then knowledge, although Hooker had discovered Bacillaria in the soundings from the south sea. Some years before, Lieut. Brooke, of the United States Navy, had been employed in surveying the Sea of Kamtschatka and Prof. Bailey wrote on the specimens. It was in a letter to Lieut. Maury, of the National Observatory at Washington, D. C., dated at West Point, January 29th, 1856. He details examining three samples, as follows: —

No. 1. Sea bottom, 2700 fathoms (16,200 feet), latitude

* Proc. Bost. Nat. Hist., 1853, p. 297.

56° 46′ N., longitude 168° 53′ E., brought up by Lieut. Brooke, with Brooke's lead.

No. 2. Sea bottom, 1700 fathoms (10,200 feet), latitude 60° 15′ N., longitude 170° 53′ E., brought up as above, July 25th, 1856, and

No. 3. Sea bottom, 900 fathoms, temperature (deep sea) 32° Saxton, latitude 60° 30′ N., longitude 175° E.

He says that "a careful study of the above specimens gave the following results: —

"First — All the specimens contain some mineral matter which diminishes in proportion as the depth increases, and which consists of minute, angular particles of quartz, hornblende, feldspar and mica.

"Second — In the deepest soundings (No. 1 and No. 2) there is least mineral matter, the organic contents (which are the same in all) predominating, while the reverse is true of number three.

"Third — All the specimens are very rich in the siliceous shells of the Bacillaria, which are in an admirable state of preservation, frequently with the valves united, and even retaining the remains of the soft parts.

"Fourth — Among the Bacillaria, the most conspicuous are the large and beautiful species of *Coscinodiscus*. There are also, besides many others, a large number of a new species of *Rhizosolenia*, a new *Syndendrium*, a curious species of *Chætoceros* with furcate horns, and a beautiful species of *Asteromphalus* with from five to thirteen rays, which Bailey proposed to call *Asteromphalus brookeii*, in honor of Lieut. Brooke, to whose ingenious device for obtaining deep soundings, and by whose industry and zeal in using, we are indebted for these and many other treasures of the deep.

"The specimens contain a considerable number of the beautiful, siliceous shells of the Radiolaria. No Foramenifera have been detected."

In November, 1856, I made the personal knowledge of Prof. Bailey when I visited him at West Point and spent sev-

eral hours working at the microscope. They were delightful hours, for I enjoyed them immensely, and although he was weighted down by the disease which terminated his life soon after, he could not refrain, although warned to do so, from entering enthusiastically into the work in hand. He then gave me a slide from West Point of *Meridion circulare*, and one of Radiolaria from Barbadoes. He also gave me some of the celebrated "Bermuda tripoli," and some of the original deposit of fresh water Bacillaria from West Point. He likewise presented me with a copy of his "Notes of Microscopic Forms Found in the Soundings of the Sea of Kamtschatka," then published in the *American Journal of Science and Arts*, Volume XXII, for 1856, page 1. This has a plate with figures of the various forms found.

COLLECTING AND PRESERVING DELICATE ORGANISMS.

BY CHARLES F. ROUSSELET, F. R. M. S.

(Mr. Charles F. Rousselet, of London, England, at the recent meeting of the International Zoological Congress in Philadelphia, met Mr. Edward Potts, of Media, Pa., by appointment, and procured from him specimens of local Polyzoa of species not native in England. Among these were Pectinatella, Pottsiella and Urnatella. He was desirous of making the attempt to acclimatize these forms in certain canal waters in London, and afterwards wrote Mr. Potts, under date of October 10th, 1907, requesting statoblasts for this purpose; adding that "specimens of these did not exist in England." Accompanying the letter Mr. Rousselet sends the detailed instructions for collecting and preserving Polyzoa and Rotifera, as given below. These directions are so precise that they cannot fail to be of value to students and collectors of these organisms.)

FRESH WATER POLYZOA.

The preparation of Polyzoa fully extended presents no great difficulties, but a little practice and patience are undoubtedly required.

As with Rotifera, these animals require to be narcotized, and cocaine or eucaine 1 per cent. solutions have proved best for this purpose.

Polyzoa are often found in large masses, but no useful purpose is served in preserving a very large colony. It is much better to pick out several small characteristic and clean pieces and after washing these well in water, and removing all branches and weeds that may interfere, place the selected pieces in a fairly large bottle of very clean water and allow the animals to expand. When they are fully expanded transfer each piece into a separate tube bottle (4 to 10 c. c.), and when the animals have again recovered add one drop of the cocaine or eucaine solution and gently mix with a pipette. So little of the narcotic must in the first instance be put in, that the animals do not mind it; they will all retract at first, but soon come out again. After ten minutes add again one

drop and mix, and then add again one drop more after every five minutes for twenty minutes to half an hour, when the polypides will appear fairly rigid and will no longer retract when touched with a needle. Then add a pipette full of the narcotic and wait another five minutes, when the animals will probably be ready for killing and fixing.

The killing is best done by adding a large pipette full of formalin 10 per cent. (commercial formalin 10 parts, water 90 parts).

After a quarter of an hour the extended and fixed Polyzoa must be transferred into another bottle containing formalin 5 per cent., in which they are preserved permanently; fill up the bottle to the top and in putting on the cork gently squeeze out the superabundant fluid so as to close the bottle without leaving an air bubble.

Formalin 10 per cent. fixes and 5 per cent. preserves Polyzoa white and transparent; it may bleach the tubes somewhat, but this is no great disadvantage.

Very weak osmic acid may be used for fixing, but it stains the animals more or less.

The different species of Polyzoa vary somewhat in their behavior under the narcotic. Should a specimen not come out after the first drop of cocaine, it will show that it has received too much of it, and the colony must be removed to a bottle of clean water and left there for some time to recover.

I may mention that it is of no use applying a dose of the narcotic and allowing the Polyzoa to die in it; the polypides will simply curl up and become macerated and show no structure when fixed.

When collecting Polyzoa, the statoblasts, which are very characteristic of the various fresh water species, should always be searched for and preserved at the same time.

Polyzoa are found attached to the stems and leaves of aquatic plants in lakes, canals, water reservoirs, backwaters of rivers and slowly moving streams; also on submerged

timber, stones and shells, often at considerable depth. A loaded three pronged hook attached to a strong line, for bringing up weeds, etc., from the bottom, is a very good method for discovering Polyzoa.

ROTIFERA.

The following instructions have been drawn up for the use of collectors in distant lands, or away from home, when an examination of the living material is not possible. The Rotifers are thus obtained in bulk and preserved for future study.

A. PELAGIC ROTIFERS.

I. Collect with plankton net, or with small silk straining net with bottle attached, in clear water and amongst aquatic weeds until a large bottle full of the material has been obtained.

II. Transfer the material into a window tank (or large, clear bottle) and allow to stand for an hour or two, and place the tank so that it is illuminated obliquely on one side only. All floating debris and dirt will fall to the bottom and the Rotifera will collect and can be seen like a cloud on the illuminated side of the vessel, mostly near the surface. Here they can be picked up clean with a pipette and transferred to a small tube bottle (2 to 6 c. c.)

III. The narcotizing process is performed in this tube by adding one drop of eucaine (or cocaine) 1 per cent. solution for every 2 c. c. of water it contains, and mixing. After five minutes the same quantity of the narcotic is again added. The Rotifers will continue to swim about, but gradually they will fall to the bottom, so that in say fifteen minutes from the beginning they can be killed and fixed.

IV. The killing and fixing is done by adding one drop of 1 per cent. osmic acid solution for every 4 c. c. of fluid, and mixing rapidly. The tube is then allowed to stand for a quarter of an hour, then the clear fluid is pipetted off, and

the bottles filled with 7 per cent. formalin. This is repeated four times to get rid of all traces of osmic acid and also floating particles of dirt, and then the tube is corked as full of fluid as possible, after placing in it a slip of paper with a number and date and place of collection written with pencil. In order to obtain also some of the loricated Rotifera fully contracted, it is advisable to add to the tube a pipette full of the unnarcotized living forms immediately after the osmic acid has been added, as certain characters are better seen in the fully contracted animals.

B. SEMI-PELAGIC ROTIFERS,

that is, forms which are found mostly creeping on, or temporarily attached to aquatic plants, are best obtained by collecting a quantity of these plants (*Ranunculus*, *Myriophyllum*, *Ceratophyllum*, *Anacharis*, moss, etc.) and placing these in a large vessel with just sufficient water to cover the plants. By allowing this to remain (not in the sun) for several hours, or over night if necessary, all the animals will be driven by asphyxiation to near the surface, and towards the light side of the vessel, where they can be picked up with a pipette, and prepared as before.

C. FIXED ROTIFERS.

These are more difficult to prepare, and must be treated individually to obtain satisfactory results. However, small twigs of weeds on which such Rotifers can be perceived with the lens may be fixed and preserved (with or without narcotization) for identification.

D. FINALLY,

it is advisable to dry some of the weeds, particularly aquatic moss (without squeezing out the water). Some Rotifers can be hatched from eggs after a prolonged state of dryness.

RAPID PRESERVATION.

Should want of time or other circumstances prevent the

adoption of the above more elaborate narcotizing method, then a rough and rapid collection may be made as follows: —

Collect with the straining net and bottle and transfer material, dirt and all, into a somewhat tall tube bottle and add at once one or two drops of 1 per cent. osmic acid (or some formalin 10 per cent. if osmic acid should be absent). Every living thing will at once be killed and will sink to the bottom; after a quarter to a half hour pipette off the clear fluid, taking care not to disturb the sediment at the bottom, and fill up again with formalin 7 per cent.; repeat this once more, after which the sediment alone can be removed with the pipette into a store bottle, filled up with formalin, and corked with label inside, as before.

SUITABLE PLACES FOR COLLECTING ROTIFERS

are standing waters of all kinds, lakes, canals, ornamental waters, water reservoirs, pools large and small, cattle ponds and roadside ditches (excluding all foul and ill-smelling waters). Flowing waters and rivers as a rule do not yield much, but backwaters of rivers, and bays cut off from the river flow, and very slowly moving streams may be good. In hot countries, when other sources fail, the railway water storage tanks at the stations may prove prolific.

Before proceeding to narcotize and preserve it is as well to examine the condensed water in a flat bottle with a hand lens x 6 or 8 to ascertain if Rotifera are present.

REAGENTS REQUIRED.

I. Eucaine hydrochlorate B. 1 per cent solution. Made with 1 gramme (15 grains) of the powder dissolved in 100 c. c. (3½ ounces) of water. If eucaine is not obtainable, cocaine can be used.

II. Osmic acid. 1 per cent. solution. Best made by obtaining a small sealed tube (Grübler's) containing 1-10th gramme of osmic tetroxide crystals, which, when wanted, is broken in a wide mouthed bottle containing 10 c. c. (⅓ ounce)

of preferably distilled water; after the crystals are dissolved, which may take a few hours, the solution is transferred into a small, glass stoppered stock bottle.

III. Formalin 7 per cent., (not formaldehyde 7 per cent). For distant lands it is best to take a bottle of the commercial formalin (40 per cent. formaldehyde) which can be reduced with water as required. (Formalin 7 parts, water 93 parts, or say 1 to 13).

APPARATUS REQUIRED.

Plankton net, or stick with straining ring net, made of bolting silk (or "soft mull" cotton material) with small bottle attached.

Flat bottle.

Glass pipettes, straight, 6 to 7 inches long, provided with India rubber teat.

Bottles of various sizes.

Small tube bottles for collected specimens.

ÆGAGROPILÆ.

Through the kindness of William M. Parker, of Springfield Township, this county, the museum of the Institute has recently had added to it a specimen of ægagropila, or hair ball, taken from the stomach of a cow. The size of the specimen in question and the rather rare occurrence of such curiosities may perhaps warrant a few words on the subject.

Ægagropilæ consist of masses of matted hair, or hair and vegetable matter, found occasionally in the stomachs of certain ruminating animals. The name [derived from Greek *aigagros*, wild goat, and Latin *pila*, a ball (or *pilus*, hair) Cent. Dict.] would indicate them as commoner to the goat than to other animals. This is in keeping with the goat's reputation for gastronomic feats.

The specimen of hair ball presented to the museum was taken from the first stomach of a cow killed for beef in Camden, New Jersey. It subsequently came into the hands of Mr. Parker, who presented it to the Institute. In its present condition, after having a long interval in which to dry out, it is an approximately spherical mass, three and one-fourth inches in diameter, consisting of little else than matted cow's hair. The hair on the surface appears very much the same as hair growing on the skin of a cow.

On sectioning through the middle of the specimen, it is found to consist of the same material throughout. There is no sign of nucleus of any kind and the whole mass seems nothing but matted cow's hair held together by some sort of adhesive material. This material in its dry condition is fragile and easily reduced to powder. The integrity of the mass is preserved almost entirely by the interlocking of the strands of hair composing it. So firmly are these knit together that it is very difficult to tear the ball apart. The specimen does not present layers in its make-up, and the hairs intertwine in all directions. On the surface of the ball, however, the hairs all pointed in one way around the circumference. Whether this

was caused by rotation in the cow's stomach or whether it was caused by subsequent handling, is not known.

Microscopically the ball shows little other than hair, grains of ground-up mineral matter (silica, lime salts, etc.), and some little cementing substance. A water solution of this latter responded weakly to the proteid tests, but enough could not be obtained for certain identification without destroying more of the substance of the mass than seemed advisable. Strange to say, the ball has no odor whatever of putrefaction and smells of nothing else than cow's hair.

The manner of formation of these balls is, of course, only conjectural. Probably a few strands of matted hair, stuck together with mucous or albuminous matter, form a nucleus which grows larger and larger as more and more of the indigestible hair is taken into the stomach. The peristaltic motion of the walls of the stomach would keep it in more or less irregular rotation, thus preserving the rounded form. Further, the irritation of the lining of the stomach by the presence of this indigestible mass would produce a catarrhal condition and stimulate the flow of mucus, which would thus keep the ball sticky and ready to catch more hair.

Despite the large size of the ægagropila, it was, as already stated, not this, but the butcher's axe, that caused the death of the animal. The first three stomachs of the cow being more for storage than digestive purposes, its effect was not so great as though the ball had formed in the fourth stomach. It is hardly conceivable, however, that it was not a source of great discomfort to its unfortunate possessor.

LINNÆUS FUSSELL, M. D.

1842--1907

It is with profound regret that the Institute announces the death, on Monday, October 28th, of its Secretary, Linnæus Fussell, M. D.

Dr. Fussell became a member of the Institute in 1872 and from that time until the close of his life was one of its leading members. For the past twenty-four years he served faithfully and continuously as its Secretary. His loss to the Institute and to the community is irreparable.

In the next issue of the PROCEEDINGS a biographical sketch, covering the various incidents of Dr. Fussell's long and useful life, will be published.

MINUTES OF MEETINGS.

AUGUST 1, 1907. — Regular monthly meeting, with the President, T. Chalkley Palmer, in the chair. In the absence of the Secretary, Walter Palmer acted as Secretary pro tem. The minutes of the previous meeting were read and approved. The Publication Committee announced that the half tones and printing illustrating the article on Sycamore Mill, in the April number of the PROCEEDINGS, were the gift of H. H. Battles. The following additions to the library were reported: "Electrons," by Oliver Lodge, and "Miscellaneous Reports of the Smithsonian Institution." After a short discussion on right and left handedness, by C. M. Broomall and other members, the meeting adjourned.

SEPTEMBER 5, 1907. — Regular monthly meeting, with the President, T. Chalkley Palmer, in the chair. In the absence of the Secretary, Robinson Tyndale acted as Secretary pro tem. The minutes of the previous meeting were read and approved. Judge Isaac Johnson was proposed for membership. The following Smithsonian publications were received: "Bulletins Nos. 50, 53, 57 and 58 of the U. S. National Museum," and "Contributions from the U. S. Herbarium." The President called attention to specimens of fossil coral of the Silurian Age from Lake Superior, collected by W. W. McFarland. A new theory of aurora borealis was mentioned by John Palmer. The President announced the following Committees on Winter Course: —For October, 1907, Mrs. C. M. Broomall and John W. Palmer; for November, Prof. L. H. Watters and Dr. Kenworthy; for December, C. M. Broomall and C. Edgar Ogden; for January, 1908, Dr. T. Pratt and James G. Vail; for February, Robinson Tyndale and Henry L. Broomall; for March, Homer E. Hoopes and Dr. Fitch; for April, T. Chalkley Palmer and Lewis Fussell. After a short discussion the meeting adjourned.

OCTOBER 3, 1907. — Regular monthly meeting, with the President, T. Chalkley Palmer, in the chair. The minutes of the previous meeting were read and approved. Arthur Pusey was proposed for membership. Judge Isaac Johnson was unanimously elected to membership. The Publication Committee reported having completed the issue of two volumes of the PROCEEDINGS, and presented a detailed report of receipts and expenditures to date. The report was received and ordered to be spread upon the minutes. The following additions to the library have been received: "Zoological Bulletin, Pennsylvania Department of Agriculture, Insect Collections;" "The Soil Preferences of Certain Alpine and Sub-Alpine Plants," and "Les Observatoires Astronomiques et les Astronomes." Miss Anne Knapp Whitney presented a number of curios, including an assortment of Russian toys, late the property of our deceased member, Jacob B. Brown. On motion a vote of thanks was tendered Miss Whitney. James G. Vail exhibited specimens of calcite penetrated by wires of native silver. Following a brief discussion the meeting adjourned.

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INSTITUTE NOTES.

The paper in this issue by Mr. Charles F. Rousselet, on the narcotization and preservation of delicate organisms, is most valuable. Some samples of his method, now in the possession of Mr. Edward Potts, of Media, show the specimens preserved with the finest tentacles and tendrils extended in life-like posture. Indeed, so natural are they that it seems scarcely possible to believe the organisms are dead. The directions given by Mr. Rousselet are so complete that other workers in this line may expect equal success.

Mr. Edward Potts, of Media, whose article on Fresh Water Jelly Fish, published in the PROCEEDINGS of January, 1907 (Volume II, Number 2), will be remembered by our readers, has been busily engaged during the past summer in pursuing further his studies in this branch of science. In a recent lot of material he has had the fortune to find a specimen of three headed Hydra. The three headed form is by no means a common one, the usual Hydra having only two branches. Mr. Potts is studying carefully the process of digestion in this form of the organism and in the next issue of the PROCEEDINGS it is hoped the results of his observations will be published. It is from the Hydra that the asexual larval form of organism, first observed by Mr. Potts, develops and he is hoping to again witness this occurrence.

A subject worthy of note in the Fall issue of the PROCEEDINGS is the scant chestnut crop in this section this year. It may be the phenomenally cool Summer has been the cause of this. On the other hand this scarcity may be only an instance of the more or less regular alternation of periods of plenty and of scarcity often observed in plant life. One of the Institute members, in this connection suggests that next year's crop of chestnuts will contain comparatively few chestnut worms. Why?

OFFICERS OF THE INSTITUTE:

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Edgar T. Miller, Homer E. Hoopes and the Officers